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Proceedings of the PSARC Habitat Subcommittee Meeting November 5-7, 2002

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PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE (PSARC)
HABITAT SUBCOMMITTEE MEETING

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SUMMARY

Nine working papers were reviewed at the PSARC Habitat Subcommittee meeting on November 5-7, 2002 at the Pacific Biological Station, Nanaimo, BC. Topics covered by these papers included Marine Protected Areas, the Shorekeepers' program, scuttled vessels as artificial reefs, floodplain habitat, and offshore oil and gas off the B.C. coast. The paper titled "Development and Evaluation of Potential Performance Indicators for Marine Protected Area Siting and Zoning: Proposed Race Rocks Marine Protected Area" was concluded to be a work in progress. The purpose and objectives will be revisited and the revised paper will be reviewed at the Spring meeting. It was recommended that the paper titled "Floodplains, Flooding and Salmon Rearing Habitats: A Review" be published as a research document immediately, and that resources be made available to pursue this work as a special publication in the Fisheries and Aquatic Sciences Series in the future. All other papers reviewed were accepted subject to revision.

At the previous Habitat Subcommittee meeting in March, 2002 a Working Paper titled "Knowledge Gaps and Risks of Concern for BC Marine Environments from Offshore Oil and Gas Exploration, Development, Production, Transportation and Decommissioning" was reviewed. The Subcommittee recommended that the working paper not be upgraded to a research document; however, given the amount of useful information contained in the report, RMEC requested the paper be divided into a series of smaller, more focused, working papers. Subsequently, Habitat Managers and the authors divided the paper into the following six working papers:

1. Oceanographic and Geological Setting of a Possible Oil and Gas Industry in the Queen Charlotte Basin
2. Biogeochemical Benchmarks for Source Identification of Contaminants from an Offshore Oil and Gas Industry
3. Modelling Oceanic Fates of Contaminants from the Offshore Oil and Gas Industry with Application to British Columbia
4. State of Knowledge of Marine Ecosystems of the Northern BC Coast
5. Potential Hazards and Impacts of an Offshore Oil and Gas Industry in the Queen Charlotte Basin
6. Role of Modelling in Ecological Risk Assessment and Ecological Risk Management with Emphasis on the Offshore Oil and Gas Industry

Four of these working papers (# 1, 2, 3 and 6) were presented at this meeting. The remaining two papers will be reviewed at subsequent meetings.

In reviewing four of the six oil and gas papers at this meeting, the Subcommittee noted the need to clearly indicate linkages among the six papers in this series. Although it was felt that together these working papers would address various components of the questions posed by habitat managers for the original paper, the Subcommittee discussed the need to provide a summary document to synthesize the information and recommendations from the series of papers. It was concluded that

this issue would be revisited upon review of the final two papers at the spring meeting. The Subcommittee recommendations for each of the four working papers presented in this document do not attempt to prioritize oil and gas research needs among all papers.

The PSARC working papers reviewed at this meeting identified a number of outstanding research needs, including some science questions not encompassed in the working papers (e.g. tainting of fisheries products). It was also noted that a scientific review of the work completed to address the recommendations directed at Fisheries and Oceans Canada (DFO) from the 1986 Assessment Panel Report should be completed. The Subcommittee felt that all of the oil and gas research needs for the West Coast should be prioritized. The Subcommittee also felt strongly that DFO must retain the appropriate capacity to properly assess and prepare for a potential offshore oil and gas industry on the West Coast.

An emerging issue identified at the meeting was consideration of the recently discovered Strait of Georgia sponge reef bioherm for protection or further study. Although this complex may differ ecologically from the Central Coast sponge complexes, and is located outside of the study area of the paper reviewed at this meeting, the Subcommittee felt that it does represent an emerging issue. Consultations with fisheries management on closure zones in the vicinity of the sponge reef are recommended.

Another emerging issue related to scuttled vessels as artificial reefs. The Subcommittee expressed concern that increased fishing activity at the sites of scuttled vessels due to increased productivity/attraction of fish may make rockfish and other groundfish vulnerable.

SOMMAIRE

Neuf documents de travail ont été étudiés lors de la réunion du sous-comité sur l'habitat du CEESP, tenue du 5 au 7 novembre 2002 à la Station de biologie du Pacifique à Nanaimo (Colombie-Britannique). Les sujets traités dans ces documents portaient sur les aires de protection marine, le Programme des Gardiens du littoral, le sabordage des navires pour en faire des récifs artificiels, l'aménagement d'habitats en milieu inondable et l'exploitation pétrolière et gazière au large de la côte de la Colombie-Britannique. Les participants ont conclu que le document sur le développement et l'évaluation des indicateurs potentiels de performance pour le choix et le zonage des aires de protection marine, visant le projet de l'aire de protection marine Race Rocks (Development and Evaluation of Potential Performance Indicators for Marine Protected Area Siting and Zoning: Proposed Race Rocks Marine Protected Area), était loin d'être terminé. Le but et les objectifs seront revus et le document révisé sera étudié à la réunion du printemps. On a recommandé que le document de synthèse sur les plaines inondables, les

inondations et les habitats de grossissement du saumon (Floodplains, Flooding and Salmon Rearing Habitats: A Review) soit publié immédiatement comme document de recherche et que des ressources soient débloquées pour permettre la poursuite de ce travail et en faire par la suite une publication spéciale. Tous les autres documents examinés ont été acceptés sous réserve d'une révision.

À la dernière réunion du sous-comité sur l'habitat, tenue en mars 2002, les membres ont examiné le document de travail sur les lacunes et risques préoccupants que posent l'exploration pétrolière et gazière au large des côtes, le développement, la production, le transport et le déclassement des milieux marins de la Colombie-Britannique (*Knowledge Gaps and Risks of Concern for BC Marine Environments from Offshore Oil and Gas Exploration, Development, Production, Transportation and Decommissioning*). Le sous-comité a recommandé que le document ne soit pas finalisé et publié comme document de recherche; toutefois, étant donné la quantité de renseignements utiles contenus dans le rapport, le Comité exécutif de la gestion des ressources (CEGR) a demandé qu'il soit découpé en une série de documents de travail plus petits et plus spécifiques. Par la suite, les gestionnaires de l'habitat et les auteurs ont divisé le document en six documents de travail, sur les sujets suivants :

1. Cadre océanographique et géologique du développement éventuel d'une industrie pétrolière et gazière dans le bassin Reine-Charlotte.
2. Repères biogéochimiques pour identifier la source des contaminants découlant de la présence d'une industrie pétrolière et gazière en mer.
3. Modélisation du devenir océanique des contaminants produits par l'industrie pétrolière et gazière en mer avec application à la Colombie-Britannique.
4. État des connaissances sur les écosystèmes marins de la côte nord de la Colombie-Britannique.
5. Dangers et impacts potentiels d'une industrie pétrolière et gazière dans le bassin Reine-Charlotte.
6. Rôle de la modélisation dans l'évaluation et la gestion des risques écologiques axées sur l'industrie pétrolière et gazière en mer.

Quatre de ces documents de travail (1, 2, 3 et 6) ont été présentés à la réunion, et les deux autres documents seront examinés à la réunion du printemps.

Lors de son examen de quatre des six documents sur l'industrie pétrolière et gazière, le sous-comité a noté qu'il fallait indiquer clairement les liens entre les six documents de cette série. On a estimé que ces documents de travail pourraient couvrir différents volets des questions soulevées par les gestionnaires de l'habitat lors de la rédaction du document original, mais le sous-comité s'est interrogé sur la nécessité de préparer un résumé du document qui synthétiserait les renseignements et les recommandations formulées dans la série de documents. On a conclu que cette question serait réexaminée en même temps que les deux derniers documents à la

réunion du printemps. Les recommandations du sous-comité relatives à chacun des quatre documents de travail ne visent pas à établir une priorité pour la recherche pétrolière et gazière parmi toutes ces études.

Les documents de travail du CEESP examinés lors de cette réunion ont mis en évidence un certain nombre de besoins de recherche permanents, notamment sur des questions scientifiques non couvertes dans les documents de travail (p. ex. l'altération des produits de la pêche). On a également noté qu'il fallait terminer l'examen scientifique des travaux exécutés pour se pencher sur les recommandations visant Pêches et Océans Canada dans le rapport de la commission d'évaluation de 1986. Selon les membres du sous-comité, tous les besoins de recherche pétrolière et gazière pour la côte Ouest doivent être priorisés. Le groupe affirme aussi énergiquement que le MPO doit conserver les moyens d'évaluation et la capacité nécessaires pour se préparer au développement d'une industrie pétrolière et gazière en mer sur la côte Ouest.

À la réunion, on a soulevé la question de la découverte récente de récifs de spongiaires (biohermes) dans le détroit de Georgia, qui pourraient être protégés ou faire l'objet d'une autre étude. Ce complexe peut différer écologiquement des complexes spongiaires du Centre de la côte, et il est situé à l'extérieur de la zone d'étude décrite dans le document examiné à cette réunion; toutefois, selon le sous-comité, ce complexe représente un nouveau problème, et il recommande la tenue de consultations avec les gestionnaires des pêches sur les zones de fermeture au voisinage de ce récif spongiaire.

Les navires sabordés utilisés comme récifs artificiels représentent aussi un dossier nouveau. Le sous-comité s'inquiète du fait que l'augmentation de l'activité de pêche à l'emplacement des épaves, du fait que la productivité est plus grande et attire les poissons, pourrait rendre vulnérables les sébastes et d'autres poissons de fond.

INTRODUCTION

The PSARC Habitat Subcommittee met November 5-7, 2002, at the Pacific Biological Station in Nanaimo, British Columbia. The Subcommittee Chair, Bonnie Antcliffe, opened the meeting by welcoming the participants. During the introductory remarks the objectives of the meeting were reviewed, along with the protocol to be observed by external participants and observers. The Subcommittee accepted the meeting agenda.

The Subcommittee reviewed nine Working Papers: Summaries of each are in Appendix 1. The meeting agenda appears as Appendix 2. A list of meeting participants, observers and reviewers is included as Appendix 3.

DETAILED COMMENTS FROM THE REVIEW

H2002-03: Hexactinellid Sponge Reefs: Areas of Interest as Marine Protected Areas in the Central Coast

G. S. Jamieson and L. Chew

Rapporteurs: Trisha Hall and Vaughn Barrie

Subcommittee Discussion:

The senior author presented an overview of the working paper and the comments of three reviewers were read to the Subcommittee. The Subcommittee agreed with the first reviewer that there was adequate evidence to support the assertion that the reefs are unique and are being damaged by ground-fish trawl; however the role these reefs play in the ecosystem is still unclear. The Subcommittee and the reviewer also agreed with the author that Oceans Act Marine Protected Areas (MPAs) would offer the most comprehensive protection for these sites. The reviewer, however, was concerned that the publishing of this paper may raise expectations of immediate MPA status of the area. It was suggested that interim protection measures, such as closures through the Fisheries Act, be mentioned.

The second reviewer agreed that there was a lack of knowledge regarding the ecology of the reef systems, but felt that these limitations do not in any way diminish the strength of the conclusions drawn. The reviewer found that recommendations for protection were logical and presented a workable management option that would be useful for Fisheries Managers.

The rationale behind the suggested 5-8 km buffer zone was discussed by the Subcommittee and the third reviewer. Both noted that the size of the suggested buffer was arbitrary and that further justification was required to provide support for a buffer zone of this size. The Subcommittee discussed the current level of knowledge regarding reef size, impacts from trawl fishing, and the length of trawl tows. It was agreed that immediate protection is required and that an interim buffer zone width of one mean trawl length should be adequate until further research can be conducted. Based on the trawl lengths recorded for this paper, this would result in a buffer zone of 9 km.

The Subcommittee also discussed the need for protection of the sponge bioherm in the Strait of Georgia. It was agreed that this was an important emerging issue and although it was generally felt that this complex was too small to be considered for protection under the Oceans Act, protection is still warranted. Consultations with the groundfish fishery in this region should be considered and may lead to a cooperative agreement to protect the site.

Recommendations:

The paper is accepted subject to revision.

1) The four major sponge reef complexes in the Central Coast area are thought to be globally unique. The reefs need additional protection due to close proximity of existing groundfish trawl closure boundaries to the reef boundaries. As an immediate interim measure, fishery closures extending one mean trawl length (calculated to be 9 km) from the reef boundary are recommended to protect the sponge reefs from further physical damage. Research is recommended to determine scientifically defensible criteria for determining closure zone size and placement.

2) Serious consideration should be given to designating the reef complexes as Marine Protected Areas. This action would offer the most comprehensive level of protection.

3) Further research into the biology of these reef complexes and their ecological significance is required.

H2002-04: Development and Evaluation of Potential Performance Indicators for Marine Protect Area Siting and Zoning: Proposed Race Rocks Marine Protected Area

G.S. Jamieson and L. Chew

Rapporteurs: Trisha Hall and Cliff Robinson

Subcommittee Discussion:

The lead author presented a summary of the paper and the comments from two reviewers were read to the Subcommittee. The reviewers and the Subcommittee were concerned about the suggestion to expand the boundary of the MPA at Race Rocks when official MPA status has not yet been granted to the existing boundary. It was generally felt that the author needed to work with Oceans staff to define the purpose and questions for this Working Paper. The Subcommittee recommended that this paper continue to be a work in progress and be revised for review at the spring meeting.

Recommendations:

The paper is a work in progress. Managers and Science are formulating objectives and questions for the working paper. The paper will be revised and reviewed at the spring meeting.

H2002-05: Role of Modelling in Ecological Risk Assessment and Ecological Risk Management with Emphasis on the Offshore Oil and Gas Industry

W. Cretney, A. Sinclair, C. Wright, B. Burd

Rapporteurs: Trisha Hall and Bruce MacDonald

Subcommittee Discussion:

The lead author presented a summary of the paper and the comments from two reviewers were read to the Subcommittee. Both reviewers felt that the purpose of the paper needed to be stated more clearly. The Subcommittee agreed that this report provides a brief overview of a wide range of topics that are relevant to risk assessment and risk management in the context of potential oil and gas development on the B.C. coast. The first reviewer felt that the recommendations were excellent and that this was a very useful document that has ramifications beyond fisheries management in Hecate Strait relative to potential oil and gas developments. The second reviewer suggested that the paper also include a section on Decision Analysis in order to link the descriptions of uncertainties using Bayesian statistics and the resulting management implications. The Subcommittee felt that this paper provided useful recommendations and that further review of chemical-fate and trophic-level mass balance models is required for the development of an effective Environmental Risk Assessment guidance document.

The Subcommittee felt that the title of the paper should be reworked to "Role of Modelling in Ecological Risk Assessment with Emphasis on the Offshore Oil and Gas Industry." The Subcommittee also discussed details regarding appropriate end points for determining toxicity. In certain cases, a toxicant may in fact result in increased growth of organisms (hormesis – see below). This however, results in an increased energy requirement and if there is insufficient food supply, the organism will still die. Because of this, it was felt that the link between residues and elements that affect survival needs to be clarified. It was also felt that there is a need for caution when evaluating risks associated with short-lived contaminants. They may not remain in the environment for an extended period of time, and therefore may be difficult to detect; however they can still significantly affect biota.

The Subcommittee also discussed the issue of hormesis. While there was some disagreement over how it should be described in the paper (e.g. "hormesis" vs. "non-linear dose response"), it was agreed that the confusing results that can arise in bioassays due to hormesis could be used inappropriately in court as a legal defence. Hormesis is therefore an important issue that experts need to be aware of.

Recommendations:

The paper is accepted subject to revision.

1) In-depth reviews of chemical-fate and trophic-level mass balance models should be undertaken as a basis for an Environmental Risk Assessment guidance document.

2) A national guidance document should be prepared for ecological risk assessment procedures for offshore oil and gas activitie that would be applicable to the needs of the West Coast.

H2002-06: Biogeochemical Benchmarks for Source Identification of Contaminants from an Offshore Oil and Gas Industry

W. Cretney, M. Yunker, P. Yeats

Rapporteurs: Trisha Hall and Peter Ross

Subcommittee Discussion:

The lead author presented a summary of the paper and the comments of two reviewers were read to the Subcommittee. The first reviewer felt that this paper was an excellent literature review of this topic and highlighted the examples from the Exxon Valdez spill which illustrated the difficulty in assessing impacts when pre-spill conditions have not been determined for an area. The Subcommittee discussed the current scientific capabilities for matching a known sample to a source where there are complex spectra. It was agreed that a guidance document for the establishment of chemical benchmarks should be developed to direct industry to develop chemical benchmark profiles. It was also agreed that once oil reserves are proven, industry must provide chemical fingerprinting of the source for future reference. The Subcommittee and the reviewers felt that the recommended background study is warranted.

Recommendations:

The paper is accepted subject to revision.

1) Survey work to characterize existing petroleum, metal and radionuclide fingerprints in natural seeps, sediments, seawater and biota is required to develop guidelines in advance of exploration and development. DFO, Natural Resources Canada (NRCan) and the Department of Environment (DOE) must develop a guideline document to direct industry in the establishment of benchmark concentrations for petroleum biomarkers, metals and radionuclides to permit source identification of acute and chronic emissions from a B.C. offshore oil and gas industry.

2) Once oil reserves are proven, industry must provide chemical fingerprinting for future contaminant source identification.

3) Resources must be made available for adequate personnel and lab capabilities to develop the guidance document for the establishment of chemical benchmarks and for routine legal assessments once exploration and/or production is underway.

H2002-07: Review of Shorekeepers' Guide Data Quality and Sampling Protocols

G.S. Jamieson, R. Scrosati, C. Schwarz, C. Levings, B. Smiley

Rapporteurs: Trisha Hall

Subcommittee Discussion:

The lead author presented a summary of the paper and comments from two reviewers were read to the Subcommittee. The first reviewer felt that the conclusions were generally well supported by the data and data analyses; however, additional information appears necessary to support conclusions made of each of the sources of variability. The Subcommittee agreed and felt that the Shorekeepers' program may represent a useful monitoring tool; however, whether the data collected are scientifically defensible has yet to be determined. It was recommended that the potential utility of the data to detect time trends or inter-site differences that are of interest to Habitat Managers be formally addressed (e.g. by power analysis), and that the variance decomposition be extended to include inter-observer variability. The second reviewer and the Subcommittee felt that this paper would be a good vehicle to challenge management to determine what they will use the data for and what information they need from the program. There is a need for clear advice from managers to improve the program's protocol to ensure that the data are sufficient and appropriate.

The first reviewer also felt that from the information provided it was difficult to determine if habitat area calculations were in fact done incorrectly or if mapping was inaccurate. Also, habitat elevation errors were attributed to misunderstandings among the workers in recording numbers yet the data also indicate that errors were due to incorrect baseline determinations. The reviewer also felt that the value of the field audit in meeting the stated audit objective is questionable given the differences in the composition of audit teams and sampling times.

Another key concern of the Subcommittee was the lack of ability to properly identify organisms. Poor taxonomic identification is a major limitation to a number of programs, including Shorekeepers', and a strategy needs to be developed to address the issue.

The Subcommittee concluded that although the Shorekeepers' program may represent a useful monitoring tool, whether data collected are scientifically defensible has yet to be determined. They also concluded that poor taxonomic identification capabilities for B.C. marine species is a major limitation for a number of programs including Shorekeepers'.

Recommendations:

The paper is accepted subject to revision.

1) Resource Managers and Science should jointly determine the objectives of the Shorekeepers' monitoring program to ensure relevance and improve data quality.

2) A strategy needs to be developed to address the poor taxonomic identification capability for B.C. marine species.

H2002-08: The Intentional Scuttling of Surplus and Derelict Vessels: Some Effects on Marine Biota and their Habitats in British Columbia Waters

B.D. Smiley

Rapporteurs: Trisha Hall and Rob Russell

Subcommittee Discussion:

The lead author presented a summary of the paper and the comments of three reviewers were read to the Subcommittee. The first reviewer felt that all of the questions for the paper were addressed except for the second question, regarding the amount of habitat suitable for scuttled ships in Georgia Strait or coast wide. The Subcommittee and the first reviewer felt that the author highlighted the lack of information regarding whether ships as reefs actually increase fish biomass or merely attract from surrounding areas. Although the Subcommittee agreed that the quantitative information does not allow for a conclusion on whether an increase in productivity exists, they noted that there is evidence that suggests that there is an increase in productivity when scuttled vessels are placed appropriately. The Subcommittee felt that the localised habitat alteration associated with the covering of the benthic environment appeared to be self-compensated by the changes in species composition and abundance leading to an increase in site-specific productivity due to the addition of new substrate.

Appropriate siting was also emphasized by the second reviewer. The reviewer felt that the advice presented in the paper is valuable since it helps clarify arguments for considering the impacts to the benthic environment and puts the total area of impact in the Gulf of Georgia into perspective. The reviewer suggested conducting a study prior to and after sinking vessels as well as attaching additional reef structures (e.g.

reef balls) to provide more attachment surface and niche habitat for fish and invertebrates.

The Subcommittee discussed the use of pyrotechnics and explosives for sinking vessels and it was agreed that the use of cosmetic pyrotechnics should cease since it serves no practical purpose and likely has negative impacts on surrounding biota. The Subcommittee also felt that the use of explosives for the sinking of vessels should be limited, and only used if deemed necessary for the appropriate placement of the ship on the seabed.

The third reviewer suggested that socio-economic considerations be included in the paper. The Subcommittee felt that this went beyond the scope of the paper.

The Subcommittee concluded that scuttling of ships for the creation of artificial reefs leads to localised habitat alteration associated with the covering of the benthic environment; however, associated changes in species composition and abundance appears to increase site specific productivity because additional substrate is being added. Evidence suggests that the habitat loss is self-compensatory, and in some cases, a net gain in productivity may occur.

Recommendations:

The paper is accepted subject to revision.

1) The practice of using pyrotechnics and explosions for public and media display during the sinking events poses unnecessary disturbances and impacts to marine biota and should be discontinued.

2) The practices and procedures of using explosive detonations to sink vessels should be avoided where possible. However, if deemed necessary to ensure the proper placement of vessels, proposals should be reviewed and mitigation measures implemented to minimize impacts.

H2002-09: Oceanographic and Geological Setting of a Possible Oil and Gas Industry in the Queen Charlotte Basin

W. Cretney, W. Crawford, D. Masson, T. Hamilton

Rapporteurs: Trisha Hall and Bruce Reid

Subcommittee Discussion:

The lead author presented a summary of the paper and the comments of two reviewers were read to the Subcommittee. The first reviewer felt that the title of the paper should be modified to indicate that it is limited to physical oceanography. The Subcommittee and the reviewer also felt that the focus of water motion was on

surface movement and that little mention is made of internal motions. The reviewer felt that this issue is more pressing than the inter-annual climate variability, which the paper suggests is the most important issue to be understood. The Subcommittee felt that a second section on subsurface conditions would make the paper more complete. The reviewer also suggested a study be made of the state of knowledge in other areas with active exploration. The Subcommittee agreed and felt that the Panel of Environmental Research and Development (PERD) workshop to be held in January would be a good opportunity to glean information from experts in California to determine if their models would be useful for the B.C. coast.

The second reviewer felt that the paper gave a good review of present oceanographic knowledge of the region. The Subcommittee agreed that research needs to continue to develop a more comprehensive understanding of the oceanographic conditions in this region. The reviewer felt that it is was worth emphasizing the importance of maintaining the weather buoy array since *in situ* measurements of the winds and waves are very important for making accurate assessments of ocean-surface conditions.

The Subcommittee also discussed the need to summarize the information contained in the six PSARC papers focusing on offshore oil and gas as well as the need for a future PSARC paper to summarize and prioritise oil and gas research needs for the West Coast.

Recommendations:

The paper is accepted subject to revision.

1) Oceanographic programs must characterize such fundamental features as inter-annual climate variability, geomorphology (SEAMAP) of the region, ocean currents with special emphasis on winter conditions, shallow nearshore circulation, subsurface circulation, freshwater runoff (i.e. Skeena River plume) and giant waves.

H2002-10: Modelling Oceanic Fates of Contaminants from the Offshore Oil and Gas Industry with application to British Columbia

W. Crawford, W. Cretney, J. Cherniawsky, C. Hannah

Rapporteurs: Trisha Hall and Mike Foreman

Subcommittee Discussion:

The lead author presented a summary of the paper and the comments from two reviewers were read to the Subcommittee. The Subcommittee discussed changing the title of the paper to "Review of models for determining the fates of oil, drilling muds and produced water from the offshore oil and gas industry with application to British Columbia" in order to clarify that this is a review of models rather than

"modelling." There was also concern over the term "contaminants" as it was felt that it was too generic since the paper only dealt with three specific ones. The Subcommittee also discussed the need for research into the identification of compounds responsible for the tainting of food species. Tainting of marine life is a key component of the offshore oil and gas industry off the East Coast and whether the tainting is real or perceived, it can have serious socio-economic effects.

The first reviewer felt that the paper was an excellent examination of existing knowledge and tools for modelling the oceanic fates of contaminants from the offshore oil and gas industry in northern BC waters. The reviewer also felt that there were several data gaps not addressed in this paper that should at least be identified and summarized in a list of recommendations or conclusions.

The second reviewer felt that the paper was overall, a comprehensive report but that it should be clearly stated whether or not the paper is limited to exploratory issues or will consider the potential effects of production phase operations as well. The reviewer also felt that the section on oil-shoreline interactions was light and would have benefited from a brief discussion on surf-washing. Also, the chapter on integrated models would have been more useful if the various features of the models had been tabulated with a few paragraphs describing the important differences between them. The Subcommittee agreed that this information should be organized differently and would be more appropriate as an appendix. The reviewer also felt that more information on what sub-surface and near-bottom current measurements made to date with the Queen Charlotte Assessment Region would have been informative.

The Subcommittee felt that accurate wind measurements and forecasts are essential for spill prediction and risk assessment. Real-time winds as measured at Canadian Weather Buoys, and forecast winds based on regional, high resolution models must be available to oil spill responders in the event of an oil spill if oil and gas exploration is to take place. Currently, DFO Science has a poor capacity to predict and monitor oil and gas activities and potential consequences. This is due, in part, to data gaps in current knowledge as well as major inter-annual changes in the seawater properties in the northeast Pacific since the completion of the PERD-funded field program in 1996. Expertise on models to predict oil spill movement and effects must be maintained and research programs must continue to fill current knowledge gaps.

The Subcommittee concluded that DFO Science has a poor capacity to predict and monitor oil and gas activities and potential consequences due to major inter-annual changes in the seawater properties in the northeast Pacific since the completion of the PERD-funded field program in 1996.

Recommendations:

The paper is accepted subject to revision.

1) Expertise must be maintained in order to effectively upgrade models, provide appropriate advice and develop better model simulations of ocean currents and drift with a particular focus on winter and bottom currents.

2) Programs must continue to determine inter-annual variability in the seawater properties (e.g. salinity and temperature) of the Queen Charlotte Assessment Region.

3) Collaborative research with DOE into an atmospheric model of the region is recommended.

H2002-11: Floodplains, Flooding and Salmon Rearing Habitats: A Review

T.G. Brown

Rapporteurs: Trisha Hall and Tom J. Brown

Subcommittee Discussion:

The author presented a summary of the paper and the comments of two reviewers were read to the Subcommittee. The reviewers and the Subcommittee all commended the author on his effort in bringing together so much information into one document. Habitat Managers on the Subcommittee noted this was very useful information and that this paper has identified that the ecological significance and productivity of floodplains as fish habitat is much greater than previously recognized. It was also noted that criteria that can be used in the field to identify and qualify floodplains as fish habitat are urgently needed. The Subcommittee felt that there is a need to assemble this information in the highest publication standard possible in order to achieve wide circulation and the respect it deserves from provincial mangers. While the information needs to be released as quickly as possible, the Subcommittee agreed that additional effort should be made to upgrade the paper to a Special Publication.

Both reviewers felt the paper could be more concise in some sections. The first reviewer also suggested that the text should be rearranged to provide a stand-alone conclusions section. The second reviewer agreed and suggested that more conclusions, data interpretation and summation be included. The first reviewer also suggested inclusion of a Table of Contents and additional information on (1) coastal salmon-bearing streams that are of glacial origin, rather than rain-dominated, such as the Homathko and Kingcome systems, and (2) off-channel summer-rearing habitat.

The Subcommittee also discussed including more of an emphasis on use of the freshwater lens by fish since their obligation to be in shallow water impacts decisions on waste water disposal and near surface contamination. It was also felt that the focus seemed to be on fish changing behaviour due to impacts, but this was not

included in the data gaps. The Subcommittee also agreed that more information on management (e.g. riparian strip definition in relation to floodplains) should not be included. This topic will be covered by a future paper (proposal currently being developed).

Habitat managers on the Subcommittee concluded that the information presented in this paper was very useful. They also concluded that criteria that can be used in the field to identify and qualify floodplains as fish habitat are urgently needed. Finally, the Subcommittee recognized that this paper has identified that the ecological significance and productivity of floodplains as fish habitat is much greater than previously recognized.

Recommendations:

The document will be upgraded to a research document. In addition, resources should be immediately dedicated to pursue this work as a Special Publication.

1) Greater emphasis needs to be applied to the identification, mapping, assessment and protection of floodplain areas used as fish habitat.

2) Criteria are required to identify and qualify floodplains as fish habitat and measures to protect floodplain habitat be developed and incorporated into guidelines for habitat protection.

APPENDIX 1: Working Paper Summaries

H2002-03: Hexactinellid Sponge Reefs: Areas of Interest as Marine Protected Areas in the Central Coast
G.S. Jamieson and L. Chew

The four known sponge reef complexes in the Central Coast of British Columbia (BC) are unique in the world and are presently protected in BC by voluntary shrimp trawl fishery closures and as of July, 2002, regulatory groundfish trawl closures. There is evidence of past damage to the reefs by fishing activities, notably trawling. Fishing on them has been reduced since 1999, when voluntary avoidance by groundfish fishers was requested, but avoidance of the reefs by fishers has not been complete and recent visual surveys show continuing damage to them. The dynamics of reef-building and the ecosystem that the reefs support have yet to be determined, with the only available biological data from limited submersible visual observations (not considered in this paper) and fishery dependent observations and recordings. We (the authors) have analysed the latter, and document fishing activity on the reefs and within the voluntary shrimp trawling closure zones established around them. The four reef complexes differ in the relative abundances of targeted species around them, with Reef A (the most northern one) having proportionately larger flatfish populations around it. There has been little fishing activity around Reef B, and hence little biological data are available for it. The area around Reef D, the most southerly reef, has been the most intensively fished, with rockfish the most targeted species. For the areas analysed, highest fishing yields came not from the reefs themselves but from the areas immediately adjacent to them. We did not assess how these landings compared to areas further away from the reefs, i.e. totally outside the voluntary fishery closures. Within the voluntary closure areas and excluding the reefs, landings for all four reefs combined averaged about 1320 t per year, comprised of about 80 % targeted individual vessel quota (IVQ) species and 15 % targeted non-IVQ species. Recommendations are that for effective reef protection, there may need to be an additional 5-8 km buffer zone around the recently introduced groundfish trawl closures, which most tightly follow the presently approximated reef complex margins. Fishing activity in this potential buffer zone should be closely monitored to ensure that gear is not straying on to the reefs. Research should also be initiated to determine the ecosystem importance and associated population dynamics relating to the sponge reefs. Marine Protected Area designations are indicated as preferable to fishery regulation for long-term protection and conservation of unique living resources such as these sponge reef complexes.

H2002-04: Development and Evaluation of Potential Performance Indicators for Marine Protect Area Siting and Zoning: Proposed Race Rocks Marine Protected Area
G. S. Jamieson and L. Chew

The proposed XwaYen (Race Rocks) Marine Protected Area (MPA) presently has the 36.6 m (20 fathom) depth contour as its outer boundary, i.e., that of the existing

provincial Race Rocks Ecological Reserve. It would be in its entirety a "no-take" MPA. Superimposed over these two legislative designations is a regulatory Rockfish Protection Area (RPA) that extends to 40 m depth. The planned designation of the waters surrounding Race Rocks as an MPA based on 1) the conservation and protection of endangered or threatened marine species, and their habitats, 2) the conservation and protection of marine areas of high biodiversity or biological productivity; and 3) the conservation and protection of any other marine resource or habitat as is necessary to fulfil the mandate of the Minister. Here, we (the authors) review the nature of the habitats that would and could be protected by MPA designation in the broader Race Rocks area in the context of the area's topography, historic fishing activity, and the mobility of species with present high conservation needs. We found that 1) preferred habitats over different seasons were found to be poorly defined for virtually all subtidal marine species in BC, and particularly for finfish, and that estimation of absolute, or potential, abundances and population characteristics by species was not possible; 2) historical catch data have been collected for some species, but data were mostly landings by PFMA and Subarea, and size frequency data were unavailable; and 3) non-destructive stock assessment protocols for most commercial, relatively spatially-persistent shellfish are available, but this is not true for finfish, which occur deeper, often die when brought to the surface, and tend to be more mobile.

On the basis of our review, and recognising that MPAs need not be entirely "no-take" but rather "theatres" within which adaptive management could be more easily effected by managers to achieve desired objectives, we recommend that consideration on science grounds be given to expanding the outer boundary of the proposed XwaYen MPA, while retaining the "no-take" area at its current boundary. This would allow adaptive management, if later deemed appropriate, to be more readily effected. We also discuss the difficulties in monitoring non-destructively the characteristics of populations of species in such a deep and strong current environment as occurs at this location. As a surrogate to an MPA to assess the effects of a protected area on rockfish population characteristics, we suggest that monitoring programs to quantify spillover occurrences, i.e., the movement of individuals from a protected to a fished area where they are then caught, be initiated at the many RPAs currently being proposed in the South Coast management area. Such an initiative would provide relevant information on how the population characteristics of a wider range of species might be monitored in "no-take" portions of MPAs, when they are ultimately established.

H2002-05: Role of Modelling in Ecological Risk Assessment and Ecological Risk Management with Emphasis on the Offshore Oil and Gas Industry
W. Cretney, A. Sinclair, C. Wright, B. Burd

Mathematical models have become indispensable tools in Ecological Risk Assessment (ERA) and Ecological Risk Management (ERM). The human mind cannot deal with the multifold of interactions that can be encompassed by models. Modern environmental management must be based on the quantitative predictions of

models. That said, models do not capture reality. At best, they only capture the essence of reality, an essence that must be specified in the model. Misunderstanding, misapplication, misparameterisation, and misadventure can lead to misrepresentation of reality in models and consequent mistakes in assessment and management. Hence, models must be validated against reality and used by those that have expertise in the reality being modeled.

ERA has been defined (Suter, 1993) as "the process of assigning magnitudes and probabilities to the adverse effects of human activities or natural catastrophes." ERM has been defined (Pittinger et al., 1998) as "the process of identifying, evaluating, selecting, and implementing cost-effective, integrated actions that manage risks to environmental systems while emphasising scientific, social, economic, cultural, technological feasibility, political, and legal considerations." ERA is the realm of the science-grounded assessor who seeks to provide objective assessments of risk, whereas ERM is the realm of the informed manager who seeks to provide balanced decisions in reducing risk. The risk assessor must know why the assessment is being done and the decisions that have to be made in order to provide answers useful to the risk manager. On the other hand the risk assessor must be free of management pressure to give predestined results.

Several paradigm shifts are looming that may greatly complicate ERA and ERM over the next decade, which may be the period leading up to the establishment of an oil and gas industry of the B.C. coast. A shift is occurring in chemical toxicology from probability of effects based on exposure medium to that based on body residue. The shift is driven to some extent by the inherent toxicity concept that holds that noncarcinogenic modes of toxicity seem to be associated with different body residue ranges of chemical toxicants within organisms. It also divorces uptake processes from toxic effect by moving a step closer to the site of action, i.e., from the medium (e.g., water, sediment) to the body. Another paradigm shift, also in toxicology, is driven by the re-ascendancy from the late 19th and early 20th centuries of hormesis, which is challenging the orthodoxy of the linear, non-threshold dose-response model in ERA. Hormesis, which must be distinguished from the homeopathy, is a well-documented phenomenon in which low doses of a toxicant confer a benefit to an organism. Also returning from relative obscurity for most of the 20th century is Bayesian statistics. Bayesian statistics affords the probability that a hypothesis is true, given the evidence. In the case of ERM, Bayesian statistics allows decision-makers to choose among competing outcomes. Frequentist statistics, which have held sway for the about seven decades, cannot provide such easy to understand output. Instead, these statistics are limited to probability of obtaining the evidence, given the hypothesis is true.

H2002-06: Biogeochemical Benchmarks for Source Identification of Contaminants from an Offshore Oil and Gas Industry
W. Cretney, M. Yunker, B. Yeats

Crude oils are complex mixtures of tens of thousands of compounds. Because numerous structures are possible, most compounds can only be characterised by their elemental composition, if they are known at all. Fortunately, compounds occur

in classes or groups of similar compounds. Hence, a classification tree can be produced for crude oils and refined products that permits preliminary assessments to be made of their toxicity and physicochemical properties. For example, oils can be chemically separated into an aromatic fraction, which contains most of the toxic components, and a non-aromatic fraction, which is much less toxic. These two fractions may be further separated into boiling point ranges and thence into groups of compounds of similar structure. The order in which the classification is done is arbitrary and can be adjusted to fit the needs of the assessor.

Groups of compounds having similar structure may often be traced to common naturally occurring precursors. Such members are known as biomarkers because of their biological origins. Useful chemical biomarkers are biologically and chemically robust compounds that survive degradation when released into aquatic environments. These biomarkers thus can be used as tracers of the petroleum products released into the ocean. The presence or absence of particular compounds usually cannot be used to distinguish among crude oils or their refined products, although such distinctions can occur. Rather, it is the compositional differences in biomarker compounds that allow one oil to be distinguished from another. Various analytical tools are available to produce biomarker "fingerprints," which like human fingerprints, can be visually compared. Nowadays, however, sophisticated computer-based statistical methods often are used to make comparisons for oil identification purposes.

A major complication in the source identification of oils through their biomarker fingerprints is the presence of a background of the same and similar compounds in the environment. The biological precursors of biomarkers in petroleum are produced continuously in the environment and undergo diagenic transformations in soils or sediments to give compounds nearly indistinguishable from those in petroleum. Eroding coal and shale oil deposits and underwater oil seeps also can introduce many of the same petroleum biomarkers into sediments, biota and seawater.

Having a measure or benchmark of the background biomarker profiles may be crucial for assessing the impact of a catastrophic spill or unequivocally assigning blame or absolution for many little spills. The *Exxon Valdez* oil spill has been the showcase for modern source identification studies using biomarkers and statistical methods. The source of petroleum in the spill zone and surroundings, however, is the subject of continuing debate and litigation. Papers are still being published on the impact of the spilled oil, because no petroleum benchmark for the area was established prior to the spill event. This mistake can be avoided in the case of the Queen Charlotte basin.

During exploration and production drilling, waste muds and cuttings can be released into the marine environment. These wastes contain metals petroleum and a number of additives whose fingerprint may be superimposed upon the natural background. Although volume and density considerations as well as experience indicate that the spread and influence of these compounds would be limited and local, establishing a fingerprint for key compartments such as bottom sediments and surface microlayer would help to resolve future environmental questions.

Petroleum spills, big and little, and wastes from combustion and drilling are not the only sources of organic compounds and metals entering marine environments from an offshore oil and gas industry. Over the lifetime of an oil field, the produced water may exceed the recovered oil by as much as ten-fold. If produced water is not re-injected into oil depleted formations and is instead released at sea, it can represent a major source of petroleum and inorganic constituents. Source identification of these constituents is necessary to assess the environmental impact of produced water. As in the case of oil itself, the importance of establishing a benchmark for constituents found in produced water should not be underrated. In this regard, widespread alteration of the composition of the sea-surface microlayer is of particular concern.

H2002-07: Review of Shorekeepers' Guide Data Quality and Sampling Protocols
G.S. Jamieson, R. Scrosati, C. Schwartz, C. Levings, B. Smiley

The Shorekeepers' Guide, released by DFO in 1999 following three years of development, is currently being used by a number of volunteer groups throughout coastal British Columbia in the monitoring of intertidal ecosystems. Data have been collected since 1997, and while improvements in Guide protocols continue to be made, it requires a multi-year data series to begin a process of data quality and analysis evaluation. Here, we (the authors) present results from analyses of data that have been collected at the same locations over time to evaluate the accuracy and precision with which data are being reported, and the utility of existing data recording procedures. Our analyses need to be considered in the context that 1) some of the data analysed here were collected early in the program's development, i.e., some problems described here were identified in other ways and have already been dealt with, and 2) in the single year audit of sampling procedures reported here, logistic difficulties resulted in an excessively long time period between samplings, with the result that in some site audits, seasonal differences in community structure made the detection of possible data collection inconsistencies impossible. Nevertheless, many of the observations and recommendations presented here are relevant and constructive. Recommendations have been or are being incorporated into on-going survey and analytical procedures, and past Shorekeeper data are being edited, where possible, so as to ensure the most accurate and credible database exists.

H2002-08: The Intentional Scuttling of Surplus and Derelict Vessels: Some Effects on Marine Biota and their Habitats in British Columbia Waters
B.D. Smiley

Based on international publications and regional information, this paper reviews the biophysical effects of vessels intentionally disposed in BC waters as permitted under Section 70, Part VI of the Canadian Environmental Protection Act. In particular its purpose is to provide helpful technical background and scientific guidance to DFO biologists and managers who, some as members of Regional Ocean Disposal Advisory Committee, assess whether or not future applications for such development cause habitat alteration, disruption and destruction (HADD) under the Fisheries Act.

Since 1980, 16 vessels ranging 10-134 m length and 15-10,000 t displacement has been sunk, many now serving as popular dive reefs largely in the Strait of Georgia. Total steel and other material disposed is about 23,000 t, mostly near shore in 10 - 40 m deep water.

The largest vessels were decommissioned navy vessels prepared by the Artificial Reef Society of British Columbia and other volunteers. Since sinking operation often employ explosives, observers report fish kills and seal disturbance. Theoretical models crudely predict damaging shock waves within 200 m for fishes and 500 m for marine mammals. In addition some reef developers use pyrotechnic displays for the public that temporarily disturb seabirds and marine mammals.

In most waters, sunken vessels have a lifespan of 100 years or so, and permanently alter existing benthic habitat typically from soft or coarse substrates to a hard one. Under the vessel's footprint, infauna is smothered and its diversity and density reduced by 15 times in some cases. The high profile and vertical relief cause upwelled currents that mix the water column within 100s of meters, alter local water properties, reduce sedimentation and create turbulence and eddies. This offers new shelter for schooling fishes and enhanced habitat for encrusting filter feeders. On the adjacent seafloor, erosion and accretion can alter soft substrates up to 10 – 20 m away.

For one to two years after construction, artificial structures such as vessels simply move biomass of fishes from natural reefs one to 2 km away. Compared to nearby natural reefs and sandy areas, artificial structures exhibit an oasis-like phenomena eventually supporting, in one studied area, fish densities 30 and 70 times greater, fish abundance larger by one and two orders of magnitude and species richness more than 25% and 85%, within 3 to 8 months of reef submersion. To date the sixteen sunk vessels have a maximum footprint of one hectare or less where most biota are destroyed, and an additional 1 to 2 hectares where habitats and associated biota are indirectly changed. However the total three hectares or less of adverse effects are relatively small and localized, and not judged as significant alteration or destruction of benthic habitats. Sunken vessels can be improved as fish habitat by increasing their structural complexity and orienting properly with currents. This also enhances the sessile invertebrate and algal biomass production by adding stable substrate for settling larvae.

Through the efforts of two volunteer divers, there are at least one biological inventory for most sunken vessels in BC. The *Chaudiere* and *Church* are the best studied, and the Porteau Cove reef complex the longest studied. The time lag before fishes such as shiner and pile perch colonized is usually measured in days, because of attraction from natural habitats. The colonization of diatoms, motile and some sessile invertebrates also commences relatively rapidly within months. Limited evidence suggests that maximum species richness is reached within about two years, and

species abundance varies greatly over time. Copper rockfish are the most common and abundant of the resident fishes.

The following are some key recommendations:

- Vessel disposal should be sited in moderate current areas to avoid siltation and anoxic build-up and to increase turbulence and mixing that enhances production. They should be located in the photic zone to better ensure enhanced primary production;
- If continued, pyrotechnic displays should be more fully assessed, because of the added risk of wildlife disturbance;
- The practices of using explosive detonations to sink vessels should be further examined to devise ways of avoiding or reducing potential harm to fishes and marine mammals;
- Techniques of increasing structural complexity of scuttled vessels should be investigated and implemented as practical in order to improve reef habitat for prey species;
- The "oasis" attraction of some fish species to sunk vessels may be mitigated by siting future disposal sites two or more kilometers away from natural rocky habitats;
- The proponents in collaboration with regulators and the diving public should conduct site surveys that facilitate ongoing research and monitoring. The colonization of the vessels should also be monitored by recreational divers and diving clubs, given the proper training and co-ordination;
- All levels of government together with interested stakeholders should prepare an effective regional management plan that guides future vessel disposal as part of artificial reef development.

H2002-09: Oceanographic and Geological Setting of a Possible Oil and Gas Industry in the Queen Charlotte Basin
W. Cretney, W. Crawford, D. Masson, T. Hamilton

Research, mainly by DFO physical oceanographers, over the last decade and a half has deepened our understanding of the ocean current regime of the Queen Charlotte Assessment Area. In this accomplishment, the Department has followed one of the recommendations of the 1986 West Coast Offshore Environmental Assessment Panel Report on offshore oil and gas issues. Much about the generation of currents and the formation of eddies has been explained.

Enhanced satellite images of oceanographic features, some with superimposed current vector tracts, are now available for examination by interested parties. Graphical representations help make understandable the results of arcane mathematical equations. In this paper, extensive use of images is made to present some of the known physical oceanography of the region. Still, some phenomena require further explanation.

Oceanographic knowledge is best for summer and worst for winter. Winter is the time when conditions can be expected to be especially severe for an industry that

seeks to operate all year round. Giant, rogue waves as have been observed in the Queen Charlotte Assessment Area present a dangerous hazard to operations of an offshore oil and gas industry. Research provides some knowledge of the interaction of tidal currents and waves to create treacherous conditions. The St. James Island area off the southern tip of Moresby Island has been the focus of studies in the 1990s.

Subsea earthquakes of the right types can generate tsunamis. A giant subduction earthquake along most of the length of the area where the Pacific plate moves under the North American plate off Southern B.C and Western U.S.A. is believed to have caused a giant tsunami 300 years ago. Having happened once, this giant subduction event seems likely to happen again, perhaps once per millennia. More recent earthquakes in Chile and Alaska have sent significant tsunamis to British Columbia. Several scientists have computed computer simulations of impact of these tsunamis on northern British Columbia, but there were uncertainties in the source strengths to apply to these simulations. Recent research efforts have attempted to reduce these uncertainties. Better numerical models and bathymetric data are now available to improve past simulations. In the case of the Queen Charlotte Fault, which passes closely by the Queen Charlotte Islands, the question is can it happen at all. Landslides can generate tsunamis as well. Giant tsunamis with wave heights up to 30 m generated by slides in the Hawaiian Islands could have hit our coast in ancient times.

The seabed of the Queen Charlotte Basin presents a complex topography, as might be expected from the topographical complexity of the bordering lands. Banks and troughs due to past glaciation dominate the seabed structure of the area. The area is replete with evidence of the strong currents that surge along the bottom. Large areas show sand ripples, sand waves and sand ridges. Some of these transitory features achieve heights of 6 m. A number of slopes around banks show evidence of instability. At shallow depth under the seabed are accumulations of biogenic gas and/or thermogenic gas. Throughout much of the area, especially in Hecate Strait, sediments are infused with gas, which renders them more susceptible to liquefaction than gas-free sediments. Although a significant amount is known about the seabed geomorphology, much remains to be learned.

The Queen Charlotte Islands display a large number of liquid petroleum seeps, which provide evidence of a number of source rocks. Submarine seeps of liquid petroleum surely must exist. Evidence of gas seeps appears in acoustic survey profiles. It seems plausible that the coverage of the seabed may mirror that of the land.

H2002-10: Modelling Oceanic Fates of Contaminants from the Offshore Oil and Gas Industry with Application to British Columbia
W. Crawford, W. Cretney, J. Cherniawsky, C. Hannah

Efforts to model the oceanic fates of contaminants from the offshore oil and gas industry require both generic models and site-specific models. Generic models, which simulate the behaviour of contaminants in the ocean, have been developed over a period of several decades, and include the cumulative knowledge of

laboratory and field experiments, theoretical studies, and experience with acute and chronic releases of contaminants, assembled to provide the industry and regulatory agencies with guidelines for safe, environmentally benign operations. Oil spreading on the ocean, oil advection over the ocean by winds, and oil evaporation are examples of such processes.

The role of combining these individual processes into a computer application that will provide reasonable accounting of the risks and impacts of contaminants, is filled by integrated computer models. In the past decade several commercial products have been developed to fill this requirement, along with a few additional products developed by government and non-profit agencies. These integrated models address two issues. First, the contaminant spread and drift through the ocean must be simulated to answer questions such as:

- If contaminant is spilled at a given spot, what shoreline locations are likely to be affected?
- Where might a spill occur that could threaten a particular shoreline location of concern?
- What concentrations of contaminants will likely reach a given spot, through individual releases of large quantities, or smaller volume but more frequent releases?

Second, if hydrocarbon exploration proceeds, integrated models must be available to predict the motion of any contaminant released, to enable clean-up and protection operations.

It is expected that integrated models will be available to provide the means to address issues such as these for release of floating contaminants. In the case of drilling muds and produced water, which might be released into the ocean at reasonably small rates over the entire life of an oil and gas production region, the computer applications may require additional development. All integrated models require site-specific information. Processes such as oil evaporation, spreading, emulsification depend on features of local oil. Processes such as drift, emulsification, and shoreline adhesion require knowledge of shoreline slope and material, ocean currents, tidal currents, wind and wave regime, usually at each site in the basin, at each season of the year.

Funding was provided until 1996 by the Panel for Energy Research and Development and by Fisheries and Oceans Canada to examine the physical oceanography of the Queen Charlotte Assessment Region, with concentration of effort for seasons between late summer and early autumn. These studies provided information on the general oceanographic properties of this region, as presented in companion report #1 (see page 2 for title), and began the development of numerical hydrodynamical models of ocean currents for input to the integrated computer models. The faster computers and cheaper memory and disk storage now available will enable the required improvement of these numerical models.

H2002-11: Floodplains, Flooding and Salmon Rearing Habitats: A Review
T.G. Brown

The purpose of this review paper was to examine the relationships between floodplains, flooding, and juvenile salmon habitats. A wide range of topics were explored, these include; defining and characterizing fish habitats and floodplains, explaining flooding and hydrological processes, outlining fish behaviours, fish diets, and winter ecology. The potential impacts of forestry, agriculture, and urban development on floodplain processes and fish habitats were also explored. In developing an understanding of our current knowledge of floodplain habitats and in identifying significant knowledge gaps, over 450 references were cited.

A major flood can cause tremendous loss of property and loss of life. Thus, humans tend to view floods with fear. From an ecological prospective, floods are natural and are important in maintaining the health of the river, riparian zone, and floodplain. Fish and invertebrates are adapted to seasonal flooding. Periods of high water may serve as a cue for migration or an opportunity to move into and exploit different habitats. Floods create new channels and a succession of new habitats while eliminating others. Floods clean the substrate and alter the species composition of the riparian communities.

It is important that we maintain the natural hydrograph, permit the flooding of floodplains, support the natural avulsion of a river channel, and protect wetlands. Natural floodplains reduce the heights of floods, storing floodwaters in wetlands, and distributing the floodwaters over a wide area. They also filter storm waters, trapping sediments, nutrients, and removing pollutants. Floodplains are a major source and processor of litter. When a river is separated from it's floodplain and held to a permanent course by dykes, considerable loss of salmonid habitat will eventually result.

The wetlands associated with floodplains support the rearing of juvenile salmon. Floodplains provide habitat for juvenile salmonids in the form of seasonal wetlands, temporary tributaries, off-channel ponds, sloughs, flood-channels and seasonal estuarine drainages. When compared to lentic habitats, these seasonal habitats support a different mix of invertebrates, usually have more modified water temperatures, and may have different water quality concerns. Many of these habitats support higher densities of juvenile salmon and have higher growth rates than main channel habitats.

Coastal and interior floodplain habitats are used by a number of regionally important fish species. These fish appear to have adapted behaviours that enable them to successfully exploit seasonally flooded lands. Human activities such as forestry, agriculture, and urban development can affect salmonid floodplain habitats.

APPENDIX 2: PSARC Habitat Subcommittee Meeting Agenda

AGENDA
PSARC HABITAT SUBCOMMITTEE
November 5th – 7th, 2002
PBS – Seminar Room

November 5, 2002 Start time: 09:30

1. Introductions and PSARC meeting procedures
2. Review agenda
3. Review of WP# H2002-08: The Intentional Scuttling of Derelict and Surplus Vessels: Some effects on Marine Biota and their Habitats in British Columbia Waters. B.D. Smiley.
4. Review of WP#: H2002-07: Review of Shorekeepers' Guide Data Quality and Sampling Protocols. G.S. Jamieson, R. Scrosati C. Schwarz C. Levings and B. Smiley
5. Review of WP# H2002-03: Hexactinellid Sponge Reefs: Areas of Interest as Marine Protected Areas in the Central Coast. G.S. Jamieson and L. Chew.
6. Review of WP#:H2002-04: Development and Evaluation of Potential Performance Indicators for Marine Protect Area Siting and Zoning: Proposed Race Rocks Marine Protect Area. G.S. Jamieson and L. Chew.
7. Review of WP #:H2002-11: Floodplains, flooding and salmon rearing. T. Brown

November 6, 2002 Start time: 09:30

8. Review – WP# H2002-09: Oceanographic and Geological Setting of a Possible Offshore Oil and Gas Industry in the Queen Charlotte Basin. W. Cretney, W. Crawford, D. Masson, and T. Hamilton.
9. Review of WP# H2002-06: Biogeochemical benchmarks for source identification of contaminants from an offshore oil and gas industry. W. Cretney, M. Yunker, P. Yeats.
10. Review of WP #H2002-10: Modelling Oceanic Fates of Contaminants from the Offshore Oil and Gas Industry, with Application to British Columbia. W. Crawford, W. Cretney, J. Cherniawsky1, C. Hannah.

11. Review of WP# H2002-05: Role of Modelling in Ecological Risk Assessment and Ecological Risk Management with Emphasis on the Offshore Oil and Gas Industry. W. Cretney, A. Sinclair, C. Wright, B. Burd.

November 7, 2002 Start time: 08:30

12. Sub-Committee Review of Recommendations and Final Report

13. Next meeting – Spring 2003

APPENDIX 3. List of Attendees

Subcommittee Chair: Bonnie Antcliffe
PSARC Chair: Alan Cass

DFO Participants	Tues.	Wed.	Thurs.	
* Subcommittee Members				
Andrie, Doug	X			
Antcliffe, Bonnie* (Chair)	X	X	X	
Birtwell, Ian*	X	X	X	
Brown, Tom G.	X	X	X	
Brown, Tom J.	X			
Conley, Kevin	X			
Cretney, Walt	X	X	X	
Foreman, Mike*	X	X	X	
Francis, Kelly	X			
Gould, Al	X			
Hume, Jeremy*				
Jamieson, Glen*	X	X	X	
Lamb, John		X		
Larsen, Howard	X			
MacConnachie, Sean	X			
Macdonald, Bruce*	X	X	X	
Pringle, John*	X	X	X	
Reid, Bruce*	X	X	X	
Ross, Peter*	X	X	X	
Russell, Rob*	X			
External Participants				**Affiliation**
Barrie, Vaughn*	X	X		NRCAN
Conway, K	X			GSC-PGC
Hawley, Alex		X		University of Northern BC
Johnston, Tom*	X	X	X	BC Ministry of Fisheries
Leblond, Paul	X	X		PFRCC
Marliave, Jeff	X			PFRCC
Robinson, Cliff*	X	X		Parks Canada
Standing, Sean	X			Environment Canada
Sullivan, Dixie	X			Environment Canada
Rapporteur:				
Hall, Trisha	X	X	X	

Reviewers for the PSARC papers presented at this meeting are listed below, in alphabetical order. Their assistance is invaluable in making the PSARC process work.

Doug Andrie	DFO, Pacific Region
Brenda Bauer	DFO, Pacific Region
Bev Bravender	DFO, Pacific Region
Peter Chapman	EVS Environmental Consultants
Ken Denman	DFO, Pacific Region
Melody Farrell	DFO, Pacific Region
Merv Fingas	Environment Canada
Garry Fletcher	Pearson College
Kelly Francis	DFO, Pacific Region
Dale Gueret	DFO, Pacific Region
Ray Lauzier	DFO, Pacific Region
Kenneth Lee	DFO, Maritimes Region
Sally Leys	University of Alberta
Maowen Li	NRCAN
Sean MacConnachie	DFO, Pacific Region
Kee Mucshenheim	DFO, Maritimes Region
Richard Pawlowicz	University of British Columbia
Randall Peterman	Simon Fraser University
Rob Russell	DFO, Pacific Region
William Seaman	University of Florida
Kent Simpson	DFO, Pacific Region

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